

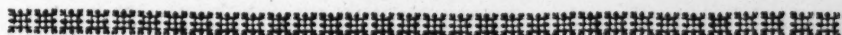
EXPERIMENTAL MAGNETISM,

O R,

Some New Discoveries in that Branch

O F

NATURAL PHILOSOPHY.

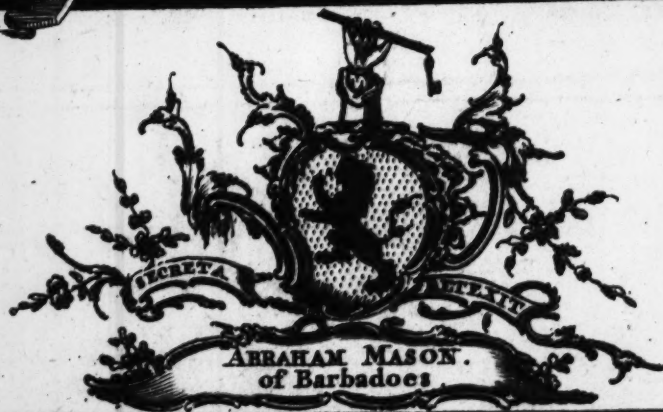
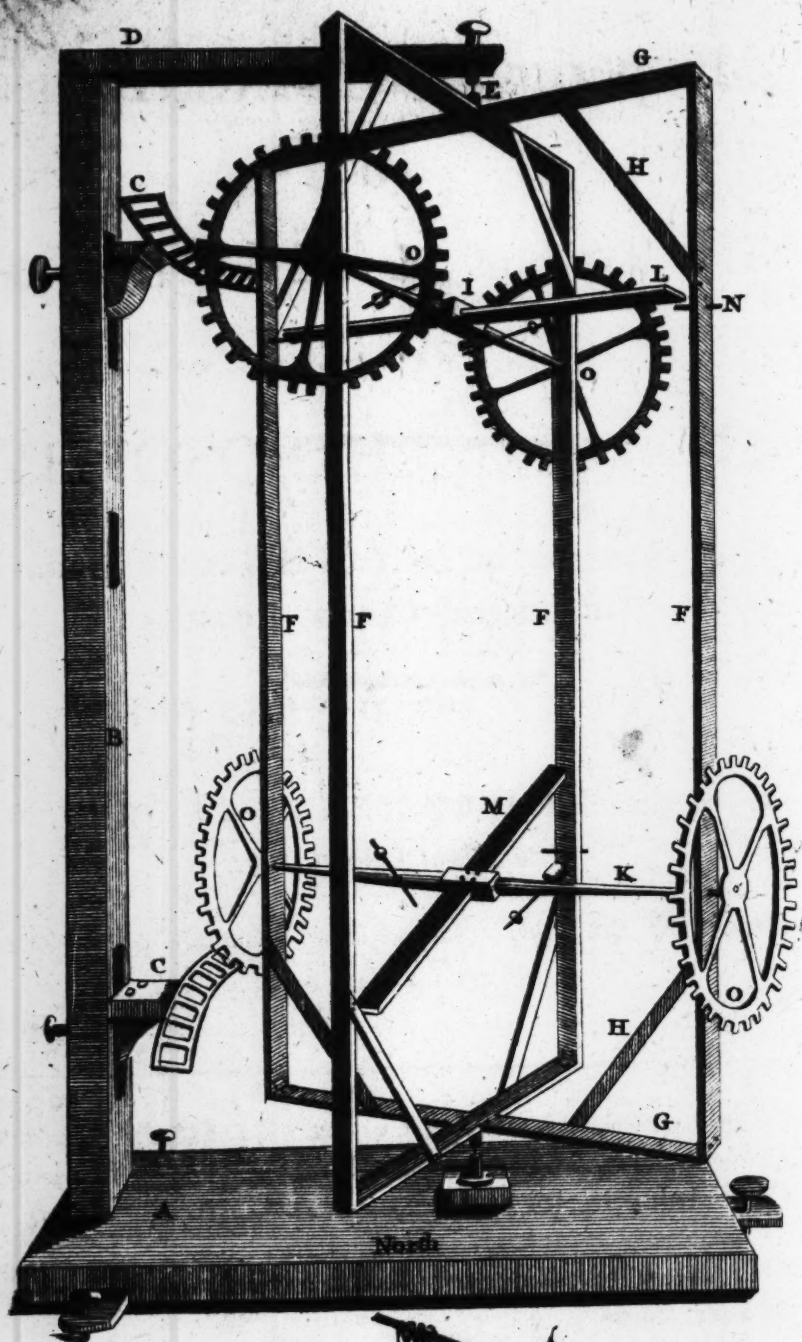


PHYSICAL MAGNETISM

OR

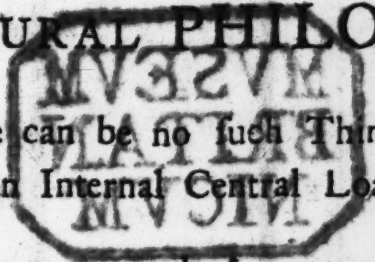
NATURAL PHILOSOPHY





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Experimental MAGNETISM,
OR,
The Truth of Mr. Mason's Discoveries,
IN THAT BRANCH OF
NATURAL PHILOSOPHY,



That there can be no such Thing in Nature, as
an Internal Central Loadstone,

PROVED and ASCERTAINED,

By the Rev. TEMPLE HENRY CROKER, A.M.
of *Christ Church, Oxon*:

K

Reader of the *Temple Church*, and Chaplain to the Earl of
HILLSBOROUGH.

Quid quæris, Carneades, Cur hæc ita fiant? Non reperio
Causam: later fortasse obscuritate involuta Naturæ; non enim me
Deus istam scire, sed his tantummodò uti, voluit.

CICERO.

Carneades, fragili quærens illidere dentem,
Offendet solido.

HOR.

L O N D O N:
Printed for J. COOTE, at the King's Arms, in
Pater-Noster-Row. 1761.

Experimental Mechanics

OR

The Theory of the Motion of Solids

IN THE STATE OF

NATURAL PHILOSOPHY



That there is a connection between the motion of solids and the motion of fluids

Proved and Ascertained

By the Rev. THOMAS HENRY GREGORY, A.M.
of Christ Church, Oxford

Reader of the Royal Society, and Chaplain to the King of Great Britain

Printed by J. Johnson, St. Paul's Church-yard, London

1800

LONDON
Printed for J. Johnson, at the Strand, near St. Paul's Church-yard

TO THE REVEREND
JOSEPH BROWNE, D.D.

Provost of **QUEEN'S COLLEGE,**

Vice-Chancellor of the University of

OXFORD,

Professor of NATURAL PHILOSOPHY,

A N D

Chancellor of the Diocese of HEREFORD.

PERMIT me, most Worthy Sir,
to entreat the Sanction of Your Name
to a Work, which more peculiarly belongs
to Your Province; a Work, which would
naturally have claimed that Privilege from
Your Candour, if the Author had never
been honoured with Your Friendship.

A grateful Remembrance of those happy
Years I passed under Your Patronage, makes
me with Pleasure catch at this first Oppor-
b tunity

tunity of acknowledging Your many Favours; and Your wonted Indulgence emboldens me to hope, the Deficiencies of these Sheets may possibly be pardoned.

Your solid Learning and Judgment, may point out these Studies to some abler Hand, who may carry them on to a far higher Degree of Perfection, may render himself famous, and them truly Useful to the World; I have sufficient Honour in subscribing myself,

Your most Obligated,

most Devoted,

most Humble Servant,

TEMPLE HENRY CROKER.

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them to account for every Appearance; but deny their first Position, and their Science is at an End. We have happily seen Modern Improvements in Experimental Philosophy, which have banished that vague and inconsiderate Manner of raising a System, and have produced real and certain Laws, which cannot be controverted. The Hypotheses of Antiquity have been deservedly laughed out of the Precincts of Science; and Ridicule can only secure itself a Reception among Candid Observers, where the Foundation for it is Just and Real. How delicate, and yet how severe, is the Sarcasm of Dean *Swift* in his *Flying Island*, upon the Internal Central Loadstone, where he makes the *Laputan* Philosophers descend in Person, and settle their Central Loadstone as they would chuse to have it; thus intimating, that without that Descent, they could not pretend to describe it? This witty Raillery is now passed over with a Smile, and leaves no deeper Impression; but will be felt with redoubled Force, when once Experiments have demonstrated, that there really in Nature can be no such Thing.

The

The Machine, constructed for a Perpetual Motion, by Mr. *Abraham Mason* of *Barbadoes*, upon the Principles of that Hypothesis, would have been a real Advantage to its Author, and at least an Amusement to the Publick, if it had succeeded: The Failure of it is a real Advantage to the Publick, by furnishing them with an Opportunity of discovering and settling so useful a Science as that of Magnetism; and its Author must content himself, with the Pleasure of seeing that Knowledge easily and cheaply communicated to them, which he has been at so much Trouble and Expence to collect: In the former Case, he might be supposed to act from interested Motives; in the latter, he can only be influenced by a sincere Love of Truth, and a Desire of having it disclosed for the good of the Community; and he would have thought himself peculiarly happy, had he discovered these Truths through any other Medium, than that of constructing a Machine for a Perpetual Motion, the very Name of which he ever had a Dislike to, nor could any Motive, except the System of the Internal Central Loadstone, have seduced

seduced him into such an Attempt; but as by the Laws of that System, his Machine must absolutely have produced such an Effect, he would have been wanting to himself, if he had not tried it.

This Machine (a Description of which will be given at the latter End of this Work) is constructed upon such Principles, that, if either the Horizontal Effect of Magnetism were superior to the Vertical, or the Vertical Power superior to the Horizontal, (as the present System supposes, by asserting that the Power which governs the Dipping Needle, is four Times greater than that which governs the Horizontal Compass) then this Machine must begin and continue its Motion till worn out by Time, consequently be as far Perpetual as perishing Materials will allow Motion to be: but the Vertical and Horizontal Power of Magnetism are exactly equal, and consequently no Motion can arise from a Composition of their Forces; the Magnet, when rolling upon its Axis in a Vertical Plane, being attracted to the Horizon with exactly the same Force, as, when playing in an Horizontal,

zontal Plane, to the Magnetic North: So that the MAGNETIC POWER ATTRACTS, OR DIRECTS TO THE HORIZON, AND NOT TO 75 DEGREES BELOW IT; and therefore it cannot be the Effect of Pure Magnetism only, that governs the Dipping Needle; and since it is not, as will be shewn in the Sequel, THE SYSTEM OF THE INTERNAL CENTRAL LOADSTONE MUST VANISH BEFORE THIS DISCOVERY, as the fine spun Web of *Des Cartes* did, before Sir *Isaac Newton's* more convincing Philosophy.

Observe, Reader, it is not the Person, who made the Discovery, that talks in this Strain; but One, who started many Objections, (more, than he has since heard from others) and could not be prevailed upon to draw up an Account of this Discovery, till thoroughly convinced by Experiments, repeatedly tried by Mr. *Mason* and himself.

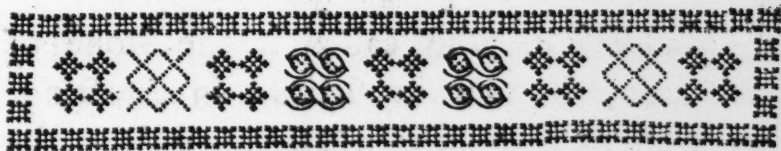
Had not Mr. *Mason* been obliged to return to *Barbadoes*, had he still remained in *England*, his Discovery might have had an abler Advocate, but in me it will have One less biaſſed, less interested to maintain it.

I advance

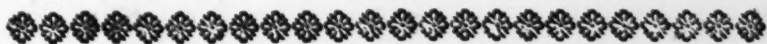
I advance only in Defence of Truth, and were I not convinced it was so, would be very cautious how I ventured to molest a Favourite System; but, to shew my Impartiality with respect to Systems, it is not only the last, but the *Cartesian* System of Magnetism also, that will be disproved in the Course of this Treatise.

In Order to this, I shall first lay before the Reader, a brief Account of the several Discoveries, or rather Stages of Magnetism; (which however to this Day, remains but little understood, the least so of any general Law of Nature) then proceed to the Laws and Observations of this New Discovery; then the Experiments in Support of those Laws; and conclude with a Description of that Machine, to which, though it failed in its first Purpose, the World is indebted for this Publication.

E X P E-



EXPERIMENTAL
MAGNETISM.



CHAP. I.

A brief Historical Account of Magnetic Discoveries.

THOUGH the Antients were acquainted with the Loadstone, they knew nothing of its Directive, but, like some of our modern Philosophers, amused themselves with only its Attractive Quality: To all such the Loadstone is at least an useless, and perhaps an insignificant Amusement.

B

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Had *Plato*, who called it the Stone of *Hercules*, known its Virtue in directing, as well as Strength in attracting Iron, he would rather have surnamed it the Stone of *Minerva*; he might possibly have supposed it twin-born with her, and that both together issued from the Thunderer's Head: but that Discovery was reserved for much later Ages; for though the *Chinese* may boast that their Emperor *Chiningus* invented the Compass, and applied it to the Use of Sailing 1120 Years before our Saviour's Nativity, yet it is much more probable that *Marco Paolo*, a *Venetian*, was the real Discoverer, 1260 Years after that blessed Æra. Had the *Chinese* been possessed of that Secret, they would certainly have made their Use of it, and have surpassed all other Nations in the Art of Navigation; which they as certainly did not: Or, had they so long kept that Secret to themselves, they would not have discovered it then, nor have permitted one of another Nation to run away with the Honour of the Discovery, if he had been so disposed. But possibly *Marco Paolo* might be afraid of a *Venetian* Tribunal, and not much ap-
prove

prove of declaring it his own Invention ; lest they should destroy him, that the Secret might die with him, and that other Nations might not rival them in Commerce by his Means. At least, if he remembered the Fate of that Person, who was said to have invented a Sort of Glass that was malleable, this may seem no improbable Conjecture.

But after all, *Flavio de Gioia*, a *Neapolitan*, is allowed to have as fair a Claim as any to the Invention of the Compass in 1302, which was above 40 Years later ; and the Territory of *Principato*, where he was born, bears a Compass for their Arms.

The *French* pretend to the Discovery from some Verses of *Guiot de Provins*, an old Poet in 1200, and from the *Fleur de Lis* at the North Point; but the *English* may as well lay Claim to it, from its Name *Compass*, which is an Original Word of this Country.

However, this much seems to be certain, that, till the Beginning of the Four-

teenth Century, the Compass, if known, was not applied to the Purposes of Navigation.

The Variation of the Magnet, or its Declination from the Pole, was first observed by *Sebastian Cabot*, a *Venetian*, in the Year 1500, and the Variation of that Variation, or its different Direction in different Years, by *Mr. Gellibrand*, an *Englishman*, in 1625. So that the whole Theory of the Compass, or, in other Words, all the Laws of Horizontal Magnetic Attraction (if we except the Diurnal Variation lately settled in a most accurate and ingenious Manner by *Mr. Canton*, F. R. S.) were known in about 300 Years after its first Discovery; from which Facts I shall presently deduce a particular Observation.

The Dipping Needle or Magnetic Needle in a Vertical Plane, was discovered by *Robert Norman*, a Compass-Maker in *Wapping*, in 1576, which acts not as the Horizontal Needle, but to a Point directly under it in the same Vertical; which Point, when first observed by *R. Norman*, was at 71 deg.
10 min,

10 min. but has since dipped lower and lower, till it has come to 74 deg. 30 min. where it now stands.

The Inventor of this Needle thought its Power much superior to that of the Horizontal, and called 71 deg. 10 min: the Line of Magnetic Direction, or rather, he says, the Line Respective, as he denies its being directed or attracted to any Point, but seems to suppose each Magnet a little Universe, governed by its own Laws, and disregarding any extraneous Impulse from the Earth or Heavens.

Though I proposed to confine myself to those Discoveries, which tended to some immediate Use in Navigation, I cannot avoid mentioning Dr. *Gilbert's Treatise de Magnetete*, in which may be seen almost every curious Phænomenon of the Natural Magnet. Mr. *Boyle* has enriched these Observations too in his Course of Experiments; not to mention many others.

Mr. *Whiston*, observing the Dipping Needle to move with a much greater
Force

Force than the Horizontal, made a very laudable and rational Attempt to bring it into Practice. He observed, that the Power of the Horizontal was but One-fourth Part of that Power, which governed the Dipping Needle, and therefore naturally concluded, that this must be the best and most accurate Instrument for Magnetic Observations; as it most certainly would, had it been influenced by Pure Magnetism only, unmixed with any heterogeneous Cause.

Many other curious Observers made similar Attempts, but were always baffled in them, and never could make the Dipping Needle answer any one useful Purpose.

Dr. *Halley* had several Voyages made at the Publick Charge; and at last, from the Observations he received, deduced his Theory, that the Earth has four Magnetic Poles, near each Pole of the Equator two, the nearest still governing the Needle; two he supposes belonging to the Earth, and two to a large Internal Central Loadstone, which therefore draws the Point of the Dipping Needle so near the Center, as
74 deg.

74 deg. 30 min. and which has a slow Motion, not quite corresponding with that of the Earth, and therefore causing the Variation of the Variation: But after all he has said, it is perfectly unknown, or at least unintelligible (to use the Words of an ingenious Observer) whether these Magnetic Poles do in fact move altogether with one Motion, or with several; whether equally or unequally; whether circular or libratory; if circular, about what Centre; if libratory, after what Manner; so that his Theory is rather ingenious than satisfactory.

The last Discovery, is the making Artificial Magnets, and greatly increasing the Attractive Force both of them and of Natural Loadstones; but as it is not found that increasing the Attractive Power has any Effect in settling or ascertaining the Directive, but rather, that tho' every Magnet has both those Powers, yet neither of them depend on, or are any Argument of the Strength of the other, I shall pass it over with this Remark, that a noted Magnetist's Pretence of making steadier Compasses by that Means,
or

or of having a better Sort, a peculiar Breed of Magnetism (like most other mysterious Pretences) must be no less false in Fact, than it is ridiculous in the Assertion.

Pardon, Gentle Reader, the incomplete Account I may here have given of Magnetic Discoveries, and join with me to lament the unhappy Cause of it. Scarce had I declared myself an Advocate for Mr. *Mason*! scarce had my first Course of Lectures been a Fortnight over; scarce was my Apparatus resettled in its peaceful Boxes, when, reviewing the few Guineas I was in Pocket, I set out to my Bookseller's, with a Determination to subscribe for Two Quarto Volumes of *A System of Experimental Magnetism* (in which to be sure the Central Loadstone would have been particularly delineated) and when, to my unspeakable Mortification, I heard *Gowin Knight*, M. D. had that very Morning * called in all his Subscriptions. O! if instead of being recalled, they had but been published that Morning; if instead of being still reserved as Mysterious

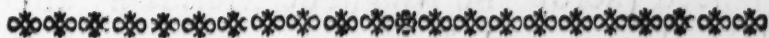
* Dec. 20. 1760. ——— Mr. *Croker's* Lectures began Dec. 5. ended Dec. 13. 1760.

Secrets, they had but been printed for Publick Use; with what Raptures should I have dwelt over them? and, before I had done with them, either have convinced myself of my own Error, or more probably the present Magnetists of theirs; unless indeed their Advocate had been more solid and accurate in them, than he has been in his *Two simple Principles*, where he calls Old Discoveries by New Names, and deduces Corollaries till he loses all Sight of his Proposition.

I shall conclude this Chapter with observing, that notwithstanding all these Discoveries, all these Lights endeavoured to be thrown upon Magnetism, it is now near Two Hundred Years since the Dipping Needle was discovered, and yet to this Day it has been made to answer no one Useful Purpose; and therefore, since the Laws of the Horizontal Needle were so long ago reduced to easy and accurate Practice, in about 300 Years, it cannot be Pure Magnetism that encreases the Power of the Vertical or Dipping Needle; for certainly then, in these last Two Centuries (which in

Mathematical Studies are equal not only to any Three Centuries, but perhaps to the whole Time since the Deluge) it would have been brought to Perfection and Use; which as it is not, it may justly be suspected of being formed upon a wrong or mixed Principle, and that 74 deg. 30 min. is not the Line of Magnetic Direction, and consequently that there is no Central Loadstone to bring it to that Point; as will be incontestibly proved in the Course of this Treatise.

C H A P.



C H A P. II.

Magnetic Laws and Observations.

IT is hoped that these Magnetic Laws and Observations, here laid down and confirmed by subsequent Experiments, will not be deemed unworthy the Attention of Naturalists; but will meet with a candid and impartial Examination from all Lovers of Truth, all Admirers of Experimental Philosophy, of real and useful Knowledge.

I.

The Magnet is attracted to the Horizon, and not to 75 Degrees below it;—therefore there can be no Internal Central Loadstone. See Experiment I.

II.

Needles, when touched, lose Gravity from the South End, the North End continuing as before;—therefore, as that destroys the Ballance they were possessed of when untouched, Needles should be bal-

lanced (across the Magnetic Meridian) after Touching, not before it, as now erroneously done.—See Exp. II.

III.

Attraction gives the Polarity, and Gravity gives what is called the Dip.—See Exp. II.

IV.

Seventy-five Degrees is that Place of Rest, which the Needle (ballanced before, not after touching) finds out;—because that is the Place where the Horizontal Attraction and Gravity meet in their Powers.—See Exp. II.

V.

Gravity keeping nearly the same in all Places, but Attraction varying considerably, causes the Variation of the Needle, with respect to its supposed Magnetic Dip;—and as Variation may be best ascertained from a mean, or middle Point, a Needle ballanced after touching, and consequently pointing to the Horizon, must be the surest
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to shew the exact Variation, and may be called a New Dipping Needle.—See Exp. II.

VI.

A Magnet may be so ballanced, as to point its North Pole to any Degree on the North Side between the Zenith and Nadir; but cannot on the South Side; except by means of the Friction on its Centers, or some Inequality on the Sides of the Magnet.—See Exp. III.

VII.

The same Force is required to depress the ballanced Magnet 75 Degrees below the Horizon, as to raise it 75 Degrees above it.—See Exp. IV.

VIII.

The North Pole of a ballanced Magnet will tend Northwardly to the Horizon from any Degree of Elevation or Depression from the South Horizon.—See Exp. V.

IX.

A ballanced Magnet requires as much Force to hold its North Pole to the Nadir, as to the Zenith.—See Exp. VI.

X. No

X.

No Needle but the Horizontal, when at Liberty to move in a Vertical as well as Horizontal Plane, carries its Points from North to South at equal Heights; which an Horizontal Needle with one half Brass will also do; but Needles ballanced to any Point above or below the Horizon, when on the Magnetic Meridian, will fall to the Nadir, or rise to the Zenith when across it. See Chap. IV.

XI.

A ballanced Magnet thrown into different vertical Planes, preserves an Equality of Motion in its Approach to, and Recess from, the Horizon; which no other Needle will in its Approach to or Recess from the Point of its Direction;—therefore as Nature is ever regular in simple Effects, the ballanced Magnet seems to be the only one actuated by a single Power; that is, by Attraction only, unmixed with Gravity, or any heterogeneous Cause.—See Chap. IV.

XII. The

XII.

The Vertical Impediment is greater towards the Poles than at the Equator; and from the Equator to the Poles encreases in a far greater Proportion than the Horizontal Attraction.—This Power stopped Mr. *Mason's* Machine from going.--See Chap. V.

XIII.

A Magnet when Vertical is attracted to the Horizon with the same Force, as when Horizontal to the Magnetic North, or the Horizontal Attraction in *London* is exactly equal to the Vertical Impediment; but in *Barbadoes* was much superior, which was said to have produced a Motion there; tho' here, as the Powers are equal, Motion is forbidden.—See Chap. V.

XIV.

Magnetism is no Fluid, nor does it act upon Surfaces; the Magnet, whether balanced edgeways or flatways, attracting with equal Power.—See Chap. V.

XV. These

XV.

These are the Effects.—The Cause of Magnetism remains still unknown, and, at least till further Discoveries (which may perhaps result from these and future Experiments) can only be resolved into those General Laws of Nature, which the Almighty Being has stamped upon the Creation.

These Laws and Observations all tend to the same Point, and show, that not only the preceding *Cartesian* System is erroneous, but that even the present Hypothesis of Magnetism laid down by Dr. *Halley* proceeds upon a Mistake: They prove, that there is in Nature no such Thing as a Central Loadstone, or a Magnetic Atmosphere, verging from South to North; but that the *Vis Magnetica* (whatever that Occult Power may be) acts, and directs the Needles, to the Horizon only. This will be proved to a Demonstration, and beyond all Possibility of Controversy, if we carefully and candidly go through the following Experiments.

C H A P.



C H A P. III.

*Experiments tried while Mr. Mason was
in England.*

EXPERIMENT I.

LET a Magnet of twelve Inches long, and of the most commodious Proportion (that is, mathematically even, strait, and exact) be prepared, and ballanced on its own Axis with as much Exactness and as little Friction as possible; so that the Magnet may turn every way equally, and rest at any Degree of Elevation, while it crosses the Magnetic Meridian at right Angles.— In this Situation turn the North End of the Magnet to 75 Degrees below the Horizon; then turn the Frame on which it hangs, about 90 Degrees round from the East, or West (whichever the North End of the Magnet pointed to) towards the North, the Magnet will immediately forsake the Place where it stood, while the Frame remained in its former Situation; and so far from be-
D ing

ing inclined to 75 Degrees below the Horizon, it will rise with some Force towards the North, ascend towards the Zenith, make several Vibrations, and at last settle itself nearly Horizontal.

Then turn the Frame to its former Situation, replace the Magnet to 75 Degrees below the Horizon, and turn the Frame round toward the South. As soon as the Magnet comes along the Meridian, or rather before, it will begin to incline Northward, and have no Manner of Stop at the supposed Place of greatest Attraction (75 Degrees below the Horizon) but will continue to the Horizon, pass it considerably toward the Zenith, return, make several Vibrations, and at last settle nearly Horizontal.

Must it not be granted, that this Effect can proceed from Attraction only, and that Gravity has no Part in it? For the Magnet, while in such a Situation, as not to feel, or show the Force of Attraction, would turn with equal Ease to, or rest at, any Point; and therefore whatever can destroy
that

that Ballance, and with it that State of Rest, which the Magnet enjoyed, must necessarily be the Effect, not of Gravity, but of some other Cause, namely, Attraction; without which it would continually have held the same State of Rest. And we are enabled to judge and assert that this Cause is Attraction, by the Force and Direction it gives to such Matter, as is disposed to receive and yield to its Impressions; and the same Argument will convince us, that the Dip of the unballanced Needle to 75 Degrees, as it is not the Effect of Attraction, must be that of Gravity. From this Experiment it is very clear, that there can be no Internal Central Loadstone; for if the Needle was attracted so near the Center as 75 Degrees by such a Loadstone, it would be almost as much affected when across as when on the Magnetic Meridian; but when across, it will stand indifferently at any Point, and when on it, at the Horizon only. They who understand the *Reductio ad Impossibile* will see the irresistible Force of this Argument.

EXPERIMENT II.

Let a Dipping Needle be properly prepared by being cleaned from Rust, or whatever might delude the Experiment. Then hang it on its Axis: (In *England* it will point to 75 Degrees below the Horizon with the North End, and consequently the South End will be as much above the Southern Horizon;) Then apply such a Weight to the South End of it, as will ballance it exactly Horizontal: Then take away the Weight; then weigh the Needle in the nicest Pair of Scales you can possibly procure: Then take it out and destroy the Verticity of the Needle, letting the Weights, that answered to the Needle, still remain in the opposite Scale: Then put the Needle into the same Scale as before, and you will find the Weight of it so much encreased by the Verticity being thus destroyed*, that
in

* This may seem surprizing, nor can we tell how to account for it, but so it is, and has been found in fifty different Trials. The Effect is plain, the Cause concealed. Whether the *Vis inertiae* of Matter is, as has been held by some, a Property distinct from Gravity, and yet when taken away by the active Spirit of Magnetism,

in order to ballance the Scales, you will be obliged to put the former Counterpoise (used at the South End of the Needle, when it had its Verticity perfect) into the opposite Scale against the Needle.

Mr. *Whiston* (whose Magnetic Experiments have been tried over and over, and who in this Particular was not only curious, but exact to a surprizing Degree of Nicety) observes, that a Needle after touching is lighter than before: This Experiment not only proves that it is lighter upon the whole, but that, as we are obliged to add as much to the South End to ballance it Horizontal when touched, as we must put into the opposite Scale (when that Virtue is destroyed) to make the Scales even; so the Gravity a Needle loses upon its receiving its Verticity or Polarity, is not regularly taken from all Parts of the Needle, but from the South End only, the Gravity

Magnetism, may carry off some Gravity with it, I leave to the Curious to determine. They may also consider, if they please, whether the Magnet is not a natural Scale, weighing the proportional Difference of Gravity from the Equator to the Pole.

of

of the North End still remaining as before; and then inclining, as Gravity in all Cases doth, toward the Center of the Earth, it produces that Dip, which has hitherto erroneously been attributed to Attraction. This in larger Needles is very clearly shewn by a neat Pair of Scales; and in smaller, though Art cannot find the Difference of Gravity, Nature will point it out to us, as they act by the same Laws, though their Minuteness throws a Veil over them; which need not be wondered at, when we consider, that the entire Power of Magnetism in Needles one Foot long, is but as 1 to 300, and that the Weight lost is but about a 4000th Part. Friction and Resistance, therefore, especially in minute Observations, are such Difficulties in the Pursuit of these Enquiries, that they frequently obscure the Truth from the most diligent Observers; but yet the Proportion, that is found between the absolute Gravity, and that of the Tendency to 75 Degrees, is certainly sufficient to account for that Gravity.

We

We have been deluded in these Enquiries by the Custom, so improperly kept up, of ballancing the Dipping and Horizontal Needles before touching; and yet not re-ballancing the Dipping as well as we do the Horizontal Needles afterwards, when by that Touch the Ballance is instantly destroyed, and the Tendency to 75 Degrees below the Horizon instantly takes Place. This Tendency therefore has been ascribed to Attraction, because it accompanies it, and the Needle receives both together; and as it seems the most powerful, the Horizontal Attraction has been deemed only a Part of the other; whereas in reality they are distinct Properties, tho' belonging to one and the same Agent; and they absolutely produce different Effects, namely, Attraction produces the Polarity, and Gravity gives the Dip: and they, who reason upon these Two Properties as if they were but One, can no more attain to the real true Nature of them, than if they were to account for a Piece of Metal as pure Gold in the Hydrostatic Ballance, which

which in Reality has a considerable Mixture of Silver.

The Reason, that the Gravity (thus given to the North, or rather taken from the South End of the Magnet) does not terminate in the Nadir, when the Magnet is along the Meridian, as it doth when it crosses it (and then indeed it more peculiarly demonstrates itself to be Gravity) is very plain; for the Attraction, which would draw it to the Horizon, if ballanced after touching, now that it is only ballanced before, is impeded by a contrary Action: The Attraction therefore will only draw it out of its perpendicular Direction towards the Horizon, till the Gravity, still encreasing as it goes farther from the Center, at 15 Degrees or thereabouts, is equal to the Attraction; and consequently where Powers are equal, Motion is forbidden. The Needle, yielding to the strongest Impulse (which is Gravity) is thereby brought so much nearer the Center of its Action, as the Gravity is stronger than the Attraction; so that if they, who have said that the

Power

Power which governed the Dipping Needle, was four Times greater than that which affected the Horizontal ; had rather said, that the Gravity, it receives at its North End when it receives the Attraction, was four Times greater than the Polarity (though that is not the exact Proportion) they would have been nearer the Truth.

These Effects however arise from those Causes, Polarity from Attraction, the Dip from Gravity. Now, as there is an exact Proportion continually preserved between the attractive and gravitating Powers, whether in Miniature or Immensity, we need not be surprized at finding them unite in one Point: An Increase of Attraction, by which a Needle would be brought to the Horizon, has an Increase of Gravity at the North End, or rather a Decrease at the South, which carries it towards the Nadir, and which mutual Increase of Attraction and Gravity, producing a similar Effect, has hitherto baffled all Enquiries into the Cause. This will account for a Needle half Steel half Brass, falling down to near 75 Degrees upon the Touch, for

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though

though such a Needle loses less Weight by one half, it acquires a proportionably less Attraction. This Union of Forces forbids the Needle's rising, and *vice versa*, while the Needle remains in the same Part of the World; but it would be absurd to suppose the same Point would be the invariable Mean between their Forces, if one of those Forces varied: Hence arises the Alteration, or Variation of the Needle in Places, where the attractive Force does not bear the same Proportion to the gravitating, as it did, where first observed: As these are distinct Properties in Nature, distinct Effects must be expected from them; for though while we can preserve the same Virtue in a Needle, we preserve with it nearly the same Gravity, be it in what Part of the World it will, yet we are not to expect the same attractive Force, since that changes with Change of Place; for Instance: Suppose in *Barbadoes* the Attraction toward the Horizon equal to one half of a Grain, and the gravitating Force equal to four Grains (occasioned perhaps by the great Distance from any large Continent Northward, as well as being so near

near a large one to the Southward) the Point of the Needle would then bear the same Proportion to half its Length, as the Gravity does to the Attraction; but by coming Northwardly, and thereby not only leaving the Continent behind, but approaching others where the Attraction encreases, we shall find it point to some other Degree; which is there equal to their respective Forces, and though not the same, yet the same Proportion.

Now, as the approaching near to, or going from large Continents, where are contained vast Quantities of such Matter as is susceptible of the Magnetic Properties, and becomes capable of affecting those Bodies, whose Nature and Situation will shew the Effects, in Proportion as they are near to, or distant * from them, sure this cannot be

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thought

* As Nature in bestowing those Properties may be supposed to deal very largely, and affect immense Quantities, they in their Turn must affect Needles at proportionable Distances; and I have heard of a noted Magnetist, who boasted that he had such Store of Magnetic Matter by him, as would affect Needles across a large Court. Now, allowing his Assertion
true,

thought an unreasonable Method of accounting for the Variation of the Dip in different Places ; and doubtless, if Care was taken to ascertain the absolute Force of Horizontal Attraction, we should find it alter in different Parts of the World, as the Dip does at present ; which Variation can, as before observed, proceed from the Difference of Attraction only, Gravity being nearly the same in all Places whatsoever.

Whatever other accidental temporary Variations may occur, are no otherwise to be accounted for, than by the Changes produced in the inner Parts of the Earth by Earthquakes, by the Formation of new Mines of Iron, the exhausting the old, and such other Causes ; all of which we cannot discover, nor are even those which we do know, perfectly regular ; so jealous is Nature of her Mysteries, and so industrious to escape the Observations of Philosophy.

true, what Dependence could there be upon any of his Experiments, tried, as they were, within that baneful, that deceiving Influence ?

We

We can only learn from Experience, that great Quantities of Stone and Iron Ore lie just beneath the Surface of the Earth, whose Position has admitted them to receive the Properties of Magnetism, and that these Properties may sometimes almost deceive us into imagining that the Needle has a real Tendency under the Horizon.

From these two Experiments, the latter of which has insensibly run into a Sort of Dissertation upon Magnetism, we may learn, that the Magnet and Dipping Needle are governed by the same Laws, and that neither of them has any Tendency to 75 Degrees below the Horizon; that being only a Deception, arising from ballancing the Needles before they are touched, and not properly considering what Effect that Touch causes, besides the Horizontal Attraction.

Hence the common Magnet ballanced after touching, and consequently so as to point to the Horizon, may be used as a Dipping Needle; and perhaps (as then it will be actuated by the Force of Attraction only,

only, unmixed with any heterogeneous Cause, and consequently must shew the Operations of that to a so much greater Degree of Perfection) it may be deemed no inconsiderable Improvement; besides that the larger Arc of a Circle any Point of a Needle describes, the more accurate will be the Observations: Besides, the same Magnet, thus ballanced, may serve both for Horizontal Attraction, and Vertical Dip; and by this Contrivance of giving it so large and extensive, so free and unincumbered a Play, we may avail ourselves of not only a less expensive, but a more compleat Dipping Needle.

EXPERIMENT III.

Let a Magnet swing in a Vertical Plane in the Manner of a Dipping Needle. Then make the North End as heavy as you will, you cannot force it beyond the Nadir, nor by adding Weight to the South End can you force the North End beyond the Zenith; but by proportioning your Weights you may ballance it so as to point its North End to any required Degree on the North Side,

Side between the Zenith and Nadir, tho' it can by no Means be forced to rest towards the opposite Horizon, without being very unequal in Weight on the Sides of the Magnet, or through Means of the Friction on its Centers; the former of which will destroy the Vertical Tendency of the Magnet in a perpendicular Line, when crossing the Magnetic Meridian; and the latter, when the Magnet is exactly horizontal with its North End to the South, will prevent its recovering its natural Situation.

And though Gravity should be equal on all Sides of its Centers, so that, relating to or respecting Motion, it may be said to have no Gravity at all, yet if from this Situation it be elevated above, or depressed below the Southern Horizon, it will return to the Northern, and after several Vibrations settle itself horizontally. So that the Northern Hemisphere may be called the Field of the North Point of the Needle's Action, and consequently the middle Point of that Hemisphere, which is the Horizon, the Center of its Motion, to which it most indisputably tends.

EXPE-

EXPERIMENT IV.

When the Magnet is swinging in a Vertical Plane, if perfectly ballanced, it will point exactly Horizontal; this is proved by Experiment I. Let its Situation be along, that is, upon the Magnetic Meridian, when consequently it must act with the greatest Force: Then add as much Weight to the South End, as will raise the North End to 75 Degrees above the Horizon: Then take off that Weight, and add it to the North End, it will depress that to 75 Degrees below the Horizon, and no farther; so that it requires as much Force to depress the Magnet to 75 Degrees below, as to raise it to 75 Degrees above the Horizon, which never could be the Case, if the Magnetic Direction was to 75 Degrees below the Horizon.

From these two last Experiments it is self-evident, that the Magnetic Direction is Horizontal; for were 75 Degrees the Mean or middle Point, to which the Needle was attracted, it might be ballanced so, as to
rest

rest 75 Degrees on the South Side, but Experiment III. contradicts that; and this Experiment shews, that it requires as great a Force to depress, as to elevate it 75 Degrees, consequently the Magnetic Attraction must act in a Horizontal Direction, in which Line all Needles would naturally point, unless impeded by Gravity.

EXPERIMENT V.

Let a Magnet be exactly ballanced upon its Axis; turn the North End of the Magnet toward the South, and elevate it 75 Degrees above the Horizon: As it will then be in direct Opposition to what has been hitherto supposed the Point of greatest Attraction, one would expect, that it would be equally inclined to return to that Point by turning to the South, and would go that Way as easily as by the North; but the Effect is quite the reverse.

This Experiment was suggested by the Common Mariner's Compass, which, when turned opposite to its due Tendency, will return either Way indifferently, the Attrac-

F

tion

tion having equal Force, and being the same, whether East or West: It therefore returns the Way most favoured by its Situation; but it is not so in the supposed Dip. For bring the North End of the Magnet down from 75 Degrees above the Southern Horizon, to only 60 Degrees above it, still it will rather rise, than descend. Bring it down to 45, to 30, to 20, and even to 10, still it will rise instead of descending: Then bring it Horizontal, or opposite the Place, where it settled itself in the North. Here the same Effect will appear as in the Horizontal Magnet; it will remain there, as being the Place opposite to that, which it naturally inclines to. Why? Not through Choice, but because in that Position the Power of Attraction cannot influence it, as drawing it, like the Reins of a Bridle, equally on each Side, or not being able to overcome the Friction on its Centers; but depress it a little lower, it will be attracted, turn, pass the Nadir, and after some Vibrations, will settle itself Horizontal to the North.

EXPERI-

EXPERIMENT VI.

This Experiment was tried with a Magnet 12 Inches long, exactly ballanced on its Axis: The North End of the Magnet was depressed to the Nadir: To keep it there, it was necessary to apply the South End of a small Magnet at about six Inches and a half Distance, the mutual Attraction between the two Magnets at that Distance being equal to the natural Tendency of the large Magnet toward the North, or rather the Horizon.

The Magnet was then inverted, the North End turned to the Zenith, and the same Effect was observed, as before; that is, the small Magnet at the same Distance of six Inches and a half was sufficient to counteract the same natural Tendency to the Horizon.

It was then tried at several other Degrees of Elevation: The Distance of the small Magnet, as a kind of Counterpoise, was carefully observed: This was repeated at

several Degrees of Depressi^on, answering to those of Elevation, and they were found to correspond exactly with each other, 15 Degrees above with 15 below, 30 with 30, 45 with 45, &c. From which Experiment any Person may be fully satisfied, that there is no other Point, to which Needles or Magnets incline, but that of the Horizon, nearly North and South; provided he will but admit some other Cause, to which the Effects, seen in the Dipping Needle, that is, its Tendency under the Horizon, may be ascribed; which no Person surely can refuse, when he is so positively convinced, it cannot be Attraction.

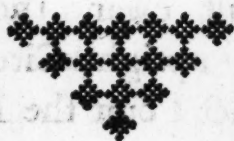
For although a Magnet swinging in a Vertical Plane may be so ballanced as to turn from the North towards the South, yet that Weight will not be equal on every Side of its Axis: for although it has succeeded that way, yet turn the Magnet the other Side up, and thereby invert its Axis, each End to the others Place, you will find it resist that Motion in that Situation; from which it may be concluded, that a Magnet ballanced every way equal on its Centers, and the Friction

Friction entirely removed (which indeed is impossible to do entirely, and therefore it rests in the exactly opposite Point) would rest in no Situation whatsoever, but Horizontally North and South.

This may be no improper Place to describe two Machines for the Needles to vibrate on. Fig. IV. is a circular flat Board with two Uprights, headed with Brass, made perfectly even for the Axis of the Needle to roll on. These are set to a Level by the adjusting Screws below, and by observing that small Brass Plummet to hang exactly at a Speck in the lower Brass Round, and just clear, though near the Upright. The upright Circle is graduated to shew the exact Point the Needle rests at. This being steady, is used chiefly for balancing the Needles across the Magnetic Meridian. Fig. III. consists of two Brass Vessels, the lower with Water in it, the other floating in that Water, but confined from the Sides by a Center, round which it has a free, easy Motion. In the upper Vessel are two Limbs at proper Distances, capped with Brass for the Axis of the Needle

to

to roll on, and a semicircular Limb to shew the Height the Point rests at. The Needle in this has a double Motion, drawing itself round till it comes to the due Magnetic North, and vibrating up and down till it rests at the Point of Attraction: And in this, Mr. *Mason's* Needle will always point to the Magnetic North Point of the Horizon. See Plate II.





C H A P. IV.

Discoveries since Mr. Mason's Return to Barbadoes.

BEFORE I enter upon these, it may not be amiss to consider the Objections that have been made to Mr. *Mason's* Discovery being founded on Truth.

Some of these Objections have been so very shallow and insignificant, as not to deserve an Answer. Such were two of a noted Magnetist, who said, the Center of Gravity was below the Center of Suspension, though he saw the Needle perform the very same Operations when each End of the Axis was inverted to the other's Place: And who supposed, that a Magnet had an insensible Bend, or that both its Ends declined, though so hard a Body, and having no Weight, but its own, to support: both which Objections, when I had the Honour of laying some Experiments before the
Royal

Royal Society, were unanimously acknowledged by that learned Body to be without the least Shadow of Argument: And yet the Objector had refused receiving any further Information, and treated the whole as unworthy his Notice upon no stronger a Plea; Or possibly he might flatter himself (like the French Physician, when told that Dr. *Harvey* had proved the Circulation of the Blood) that, had the Discovery been true, he must have hit upon it himself.

Others have told me, they saw Mr. *Mason's* Experiments, when he was in *England*; they did not very well understand them; but they were sure, there was nothing in them.—Peace be with such Observers for the future; nor would they ever have been mentioned, had I not been told that my Friends wondered I persisted, when so many solid Objections had been made to me against Mr. *Mason's* Discovery;—therefore such as they were, I was determined the Publick should see them ALL; and let them judge impartially between us.

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Fig. I.

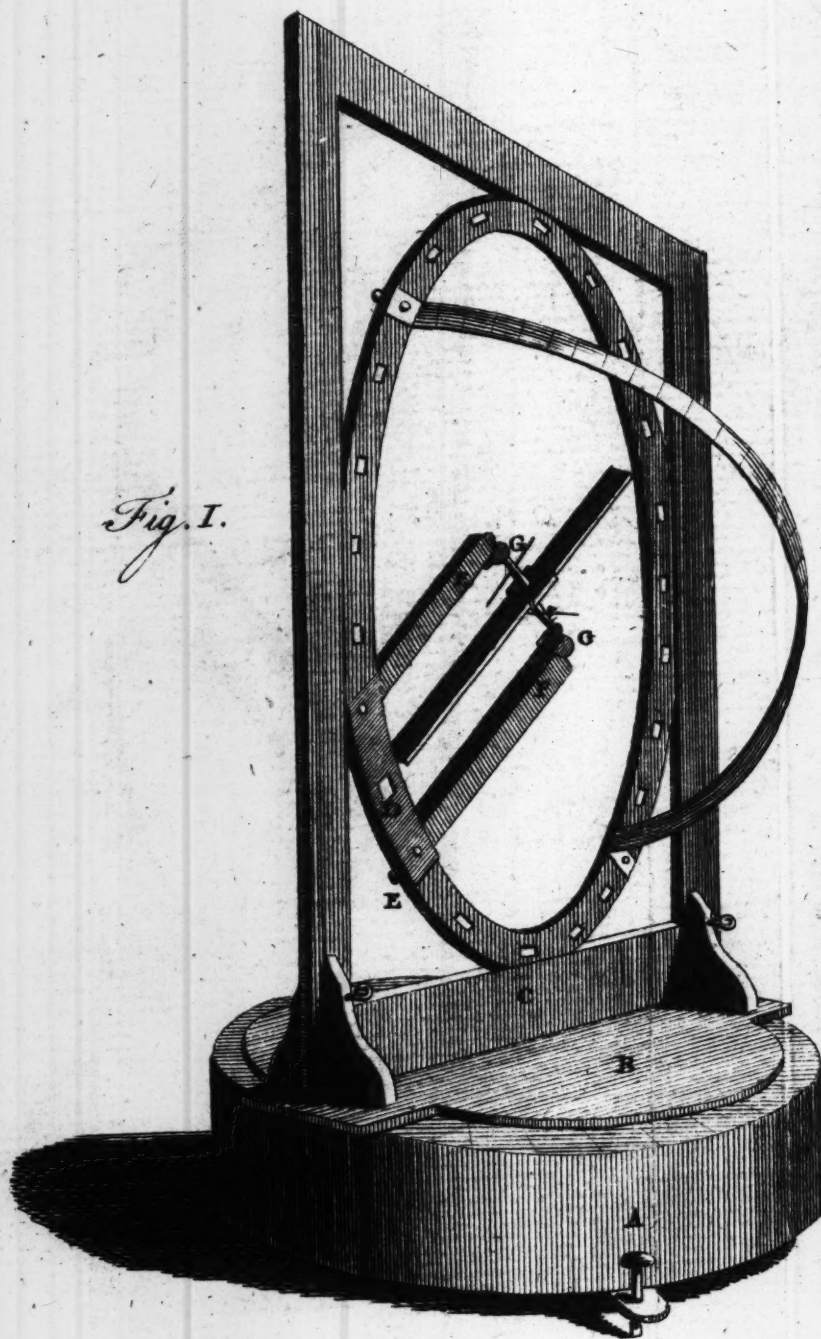
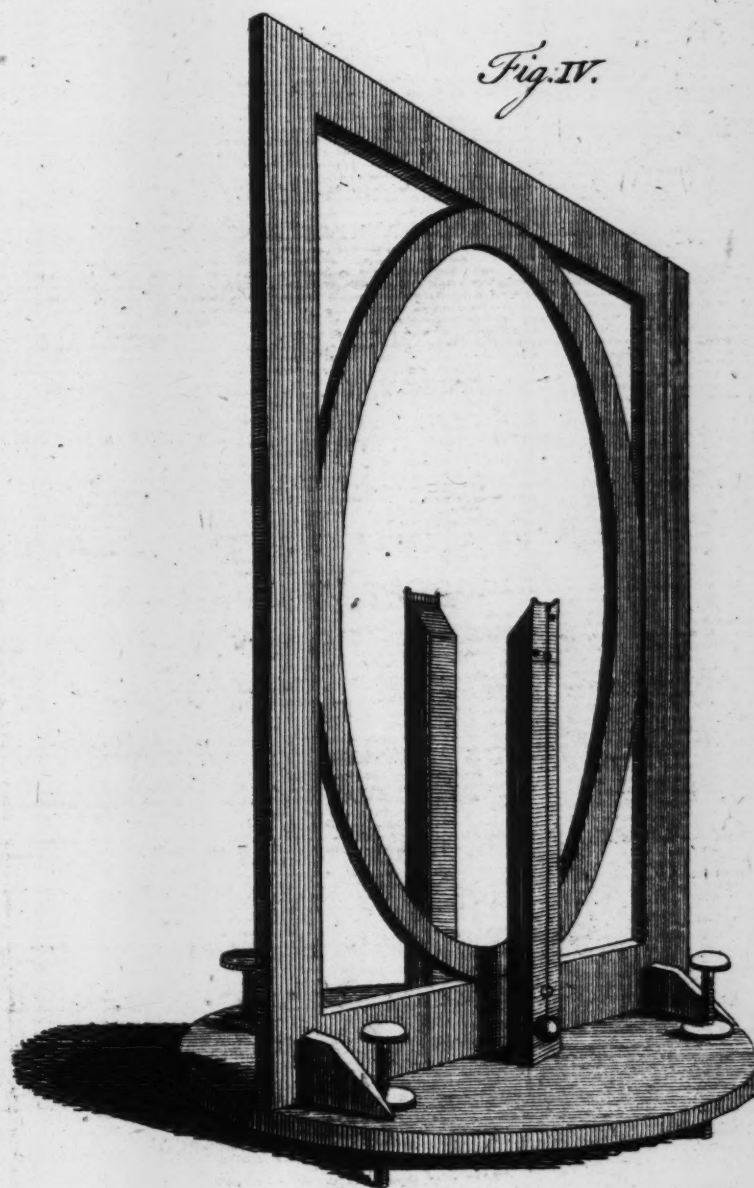
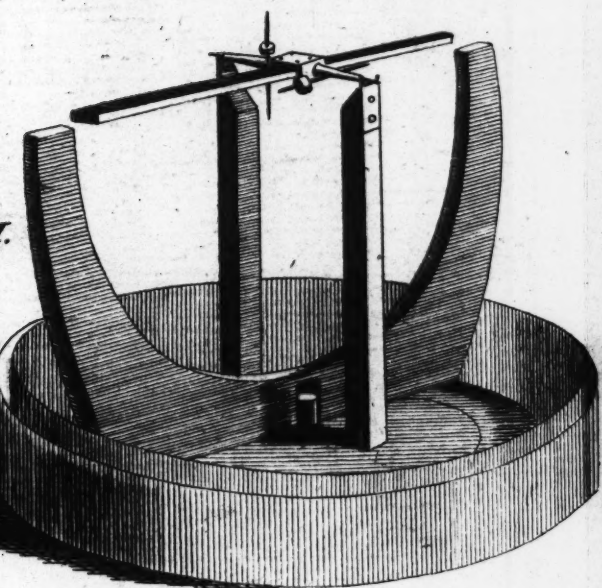
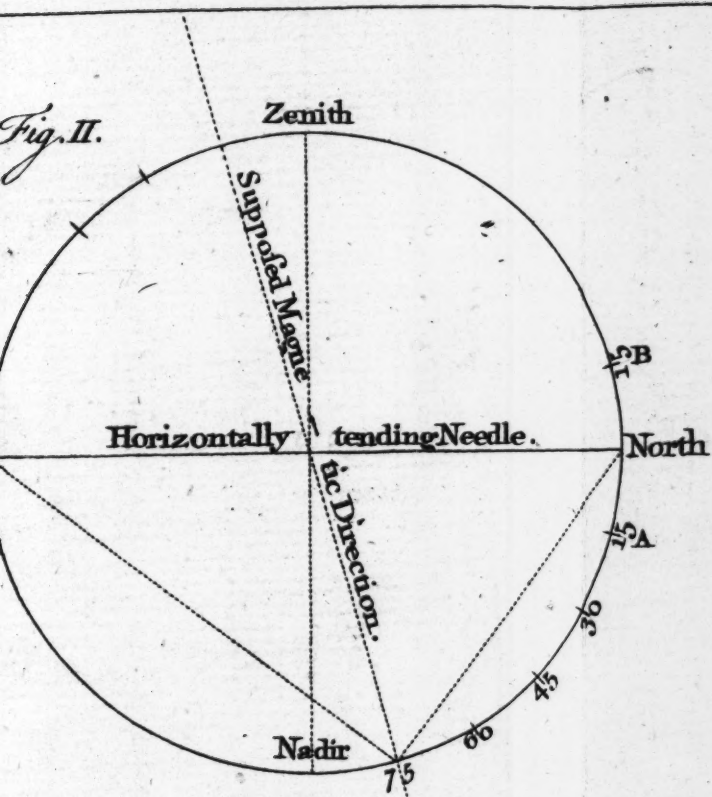


Fig. II.



Fig. III.





The most sensible Objection, and one which indeed merits a cool Consideration, is as follows.—The Reason, why the North Point of the Needle, ballanced after touching, does not descend to 75 Degrees, is, because that Tendency is counteracted by Gravity in the South End.—To give this Objection and the Answer to it fair Play, we must first consider the Mechanism of Mr. *Mason's* Needles. They are in themselves mathematically even, strait and exact. One rolls flatways, the other edgewise on its Axis, and there is no Sort of Difference in their Operations, when ballanced across the Magnetic Meridian: For there, both will rest indifferently at any Point, though when on the Magnetic Meridian, they will point at or near the Horizon only. Inserted on each Side the Axis at equal Distances from the Center and crossing each other at Right Angles, are brass Wires with Screws round them, to receive small Weights for the Purposes of ballancing the Needles.—Any Person who understands Motion, will by bare Inspection see that one of these must govern the Vertical, and the other the Horizontal Tendency ;

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and

and consequently a proper Composition of these, will make the Needle rest in any intermediate Point; that is, when it is not actuated by Magnetism, will make it rest indifferently any where; but then it is as plain, that they can have this Effect, only when the Needle is not actuated by Magnetism; for when it is, though they may make it rest at any Point, yet they cannot by any Power make it rest indifferently at all Points.

This very Observation will suffice to prove that the Attractive Power of Magnetism must be at the Horizon; for as the Sailors say, that the Compass then only fails them, when they are over the very Magnetic Pole, so the Vertical Needle will respect all Points indifferently, only when its Axis points to the Horizon.

Nor does this Supposal of a Magnetic Pole, molest Mr. *Mason's* Assertion of an horizontal Tendency, for though Magnetism may act horizontally on almost all Parts of the Earth, yet when it comes to the very Whirlpool in which it is to be absorbed

forbed (if there is in reality such a Whirlpool) it may instantly assume a perpendicular Direction. But this by the bye.

This being premised, let the Candid Examiner read over Experiment V. and then return to Figure II. in Plate II. where the Vertical Needle is supposed rolling upon its Axis, and pointing horizontally North and South. Then suppose the North End of the Needle so turned round, that the South End may point to A, at 15 Degrees below the Northern Horizon; if then let go, the imagined Weight in the South End will indeed depress that End, and bring the North End back again to its former horizontal North Point: This seems to favour the Objection; but carry the North End round so that the South End may point to B, at 15 Degrees above the Horizon, then by all the Laws of Gravity the South End should still weigh down and carry the North upwards; but it will not, and therefore Gravity is not concerned in the Motion of that Needle, and consequently Magnetism, Absolute Horizontal Magnetism is the real Mover.

Besides, as the common Compass will rest with the North Point towards the South, so will this Needle do the same, which never could be the Case, if there was Gravity in the South End, (which then must act weakest, where it is really strongest, that is, at right Angles to the Nadir) or, if the Plane of 75 was the *real* instead of the *supposed Magnetic Direction*; for then supposing the whole Frame turned horizontally round, the Needle would not preserve its Horizontality, which it absolutely does. This may be assumed *pro confesso* from the Motion of the Dipping Needle, which varies the Height of its Points as its Frame turns horizontally round, resting in the Nadir, when across the Magnetic Meridian, and rising to 75, when on it; and yet is said to be actuated by Magnetism only. The Horizontal Needle therefore should pay some Sort of Obedience to the same Laws, but it goes stiffly round, and never alters its Position, . .

Without entering into the Doctrine of Sines and compound Forces, we shall prove by Needles ballanced at other Heighths,
that

that this Peculiarity of the Horizontal Needle does not arise from counteracting its Tendency by Gravity ; for if we ballance the Needle to point to 15 Degrees above the Horizon, when it must consequently have all its Parts in the fullest Opposition to the supposed Magnetic Direction, and therefore ought, if it would in any Position, to keep at regular Heighths in the Horizontal Motion, yet this 15 Degree Needle will, when across the Magnetic Meridian, fly up to the Zenith with its North Point.

The Needle ballanced at 45 below the Horizon when on the Meridian, will fall to the Nadir when across it ; that at 45 above, will rise to the Zenith ; that at 75 above, to the Zenith ; and in short, there is no Needle, ballanced at any Point but the Horizon, that will not imitate the Motion of the Dipping Needle.

Now, shall we say that all these are the true Points of Magnetic Direction (for we see they act by the same Laws) or shall we allow the Preference to the Horizontal ? and suppose, that as that Needle is contra-distinguished

tinguished from all others, it is its Excellency, and the Purity of its Nature, which gives it that Distinction: Not to add, that, by repeated Trials, the Force of Magnetism is found to act not like that of Gravity *, strongest at right Angles, and proportionably weaker on each Side, but that the Line from the South (in Figure II. Plate II.) to 75, acts much weaker than that from the North to the same Point.

Besides, there might indeed be some Weight in these Objections, if not only the ballancing the Needle across the Magnetic Meridian produced its Horizontality when on it; but if the fixing it to the Horizon when on it, reciprocally made it possessed of a Ballance, when across; but these are

* Neither is Magnetism, as some have imagined, like Electricity; for hang a Wire across a Stick of Sealing Wax, with two Balls of Elder Pith hanging by Threads at one End of the Wire, and two Needles stuck in small Balls of Cork hanging at the other, touched similarly, and consequently repelling each other; then electrify the whole Machine, the four Balls will fly asunder, but when you discharge the Electricity, only the Pith Balls close, the Magnetism in the Needles remains still unaffected, and they as separate as before the Electricity was given.

by

by no Means convertible Propositions; for though the Ballance produces the Horizontality, that, if produced first, will create no sort of Tendency towards a Ballance.

Neither is it a Composition of Attraction and Repulsion in the North and South Ends which occasions the Needle's preserving its Horizontality in its Motion from South to North (as was ingeniously objected) for a Needle half Brass performs exactly the same Operations, as one entirely Steel; and the Brass, even if allowed to be Magnetic in a Degree (which, at least as to directive Quality, I much doubt) can never correspond so exactly with the Steel.

This may suffice for the Article of Objections, proceed we now to consider what other Proofs may result from observing the Magnet in a perfectly new, and possibly an advantageous Light.

From the former Experiments, and the Answers to these Objections, there results (not only in my own Opinion, but in that of many Learned and Unprejudiced Judges)
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an incontestable Proof of the Truth of Mr. Mason's Discovery, that *The Magnet is attracted to the Horizon, and not to 75 Degrees below it,—therefore there can be no Internal Central Loadstone.* But even in the Eye of the most partial, this however must be clear, that Gravity is concerned in the Motion of either the horizontally-tending Needle, or that dipping to 75.

The next Question is, how to discover, which is actuated by pure Magnetism, unmixed with that heterogeneous Cause, Gravity? They cannot both be influenced by a Simple and Similar Quality, their Motions are so widely different.

The next Question is, which is most likely to be actuated by a Simple Power, the One which preserves a Regularity in its Motion, or That, which does not: to which may be added, When we ballance a Needle at a Point, which both Parties agree is not the Magnetic Direction, which Needle will it imitate in its Motions? the True, or the False? that actuated by pure Magnetism,
or

or that influenced by a * Composition of Gravity and Magnetism?

The two last Questions seem to answer themselves, and Reason as well as Experience strongly plead for the Regularity of That Needle, which is actuated by a Single,

* Observe, I do not here insist upon the palpable Conviction of Experiment II. because, though it never did in Publick, that failed me twice in private; and therefore, though it answered above 50 Times, yet as it was the only one that ever did fail, I would not be so disingenuous as not to confess it. It is true, that after its first failing, it succeeded in other Trials in Brass Scales, made by Mr. *Sisson* on a new Principle, turning to the 120th Part of a Grain; but it having failed a second Time, when I least expected it, and when I thought myself equally accurate, though perhaps it might be some unheeded Mistake, I leave it to further Trials, with this Remark, that I know it has succeeded above 50 Times, when I could not be mistaken; and as it has, I can equally suppose, the Weight may sometimes be transferred as well as taken off, either of which will tally with Mr. *Mason's* Discovery. I shall therefore here subjoin the Difference of Weight in four Needles before and after touching, in which I could not be deceived.

		oz. dw. gr.			oz. dw. gr.
First.	{ Before	2 2 17 $\frac{1}{2}$	Third.	{ Before	2 3 6 $\frac{1}{2}$
	{ After	2 2 17 $\frac{1}{8}$		{ After	2 3 6 $\frac{1}{8}$
Second.	{ Before	2 2 27 $\frac{1}{8}$	Fourth.	{ Before	2 3 23 $\frac{3}{8}$
	{ After	2 2 26 $\frac{6}{8}$		{ After	2 3 21 $\frac{3}{8}$

H

Simple,

Simple, Unmixed Quality; as well as that the Third Needle, confessedly pointing improperly, must in its Motion imitate That, which does so too.

Return we then to the First Question, how to develop this reserved Secret of Nature?

The most likely Way is, to throw all these different Needles into different Vertical Planes, and observe their Motion in their Access to, and Recess from the Point of their Direction. In order to do this I endeavoured to contrive a Machine, where the Friction should be equal in all Positions; as it appeared indeed to be, by frequently repeated Experiments with the differently ballanced Needles, first emitted at 90 Degrees Distance from the Point they stood at on the Magnetic Meridian, and then emitted at the same Distance with the Axis rolling in the Plane, which the Needle had before stopped in.

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But this will appear clearer on describing the Machine*. The Solid Compass Box (A) has three adjusting Screws to set it entirely level, on which is a circular Frame (B) that moves round horizontally, supporting another circular upright Frame (C), perforated at every 15 Degrees for the fixing the sliding Machine (D) by the Screws (E). To this Brass Slider are fixed two strong Mahogany Limbs (F), with two Friction Rollers (G) on each, to receive the Needle's Axis when playing in a Vertical Plane, and a small Stop for the Axis to rest upon, when the Needle plays in an oblique or horizontal Plane: On a Level with the Top of which Friction Rollers, is a moveable semicircular Brass Limb, to secure the emitting the Needle from a proper Distance.

The first Experiments with this Apparatus, proved the Equality of the Friction, and are as follows.

* See Plate II. Fig. IV.

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Mr.

Mr. *Mason's* Needle on the Magnetic Meridian, moved,

When	VIBRATIONS.	
	N ^o .	Time.
Vertical -	4	2 in 22 sec.
Horizontal -	4	2 in 22 sec.

Needle ballanced at 45 Degrees *above* the Horizon moved on the Magnetic Meridian, when

Vertical, -	4½	2 in 19 sec.
In the Plane of 45	4	2 in 19 sec.

Needle ballanced at 45 Degrees *below* the Horizon moved on the Magnetic Meridian, when

Vertical - -	4½	2 in 19 sec.
In the Plane of 45	4	2 in 19 sec.

Dipping Needle, or Needle at 75 Degrees, moved on the Magnetic Meridian, when

Vertical - -	9½	2 in 14 sec.
In the Plane of 75	10	2 in 14 sec.

Needle ballanced so as to fall nearly to the Nadir moved, when

Vertical on the Magnetic Meridian, -	31	2 in 8 sec.
Vertical across ditto,	37	2 in 9 sec.

These

These Needles, as before observed, were all emitted at 90 Degrees Distance from the Point they rested at on the Magnetic Meridian, and their two Motions crossed each other at right Angles.

Before I proceed, I shall just observe, that the nearer the Needle comes to the Nadir on the Magnetic Meridian, its Motion is not only proportionably quicker, but increases in a much greater Degree; and that though a Needle cannot be fairly ballanced to fall quite to the Nadir, on Account of the Horizontal Attraction being then most powerful upon it, yet when it is brought pretty near it, its Motion is stronger across, than on the Meridian.

Should the Motion of the Dipping Needle be similar to that, its warmest Advocates must allow Gravity, as well as Magnetism, to be concerned in its Motion; because it will then move strongest, when not only by the *Real* Horizontal, but even by the *Supposed* Direction of the Magnetic Force, it must be least affected. When the last-mentioned Machine is perfectly Horizontal
(which

(which may be seen by turning it round with a Spirit Level) turn it so, that the Axis of the Needle may be Horizontal too, and point North and South; then emit the Needle from the Zenith or uppermost Part of the Frame, and repeat this (first with a Needle of Mr. *Mason's* Construction, and then with a Dipping Needle of the same Size) turning the Frame Horizontally round, 15 Degrees at each Emission of the Needles, and the Following Observations will result, reckoning your Degrees from the North.

CIRCULAR DEGREES.

Needles pointed to the West	Mason's Hor. N.		Dipping Needle.	
	Vibr.	Time.	Vibr.	Time.
	0	0	17	2 in 8"
75	0½	in 8"	16	2 in 8
60	1	in 14	15	2 in 8
45	2	2 in 24	14	2 in 7
30	2½	2 in 23	14	2 in 7
15	3	2 in 22½	13	2 in 6½
Magnetic North	4	2 in 22	12	2 in 6
15	3	2 in 22½	13	2 in 6½
30	2½	2 in 23	14	2 in 7
45	2	2 in 24	15	2 in 8
60	1	in 14	16	2 in 8
75	0½	in 8	16	2 in 8
East	0	0	17	2 in 8

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By this Table, made with the greatest Accuracy, every Experiment repeated at least five Times, and every Motion carefully observed, we see that the Horizontal or *Mason's* Needle encreases its Power and Velocity as it advances towards the Magnetic Meridian, and that the Dipping or 75 Degree Needle encreases its Number of Vibrations as it recedes from it.

How then is the Motion of the Dipping Needle to be reconciled with the supposing it actuated by Pure Magnetism? for Pure Magnetism undoubtedly must be strongest on its own Meridian, whether we conceive it acting as a Stream, or an Attractive, or Directive Quality?

And as to the Machine, here at least there can be no Deceit, no Difference of Friction; for the Friction Rollers are the same for both Needles, they are at the same Elevation, and they both preserve an exact Horizontality all round.

Mr. *Mason's* Needle is accordingly regular; while the Dipping Needle is not
only

only irregular, but weakest where through Magnetism it ought to be strongest: and what is very observable, its Motion is perfectly equal in Time, when it advances towards right Angles with Mr. *Mason's* asserted, and I think I may add, demonstrated, Horizontal Course of Magnetism.

But let us advance a Step further, and see how these Needles act in Elevated Planes, whether their Motions are similar to those in these Circular Experiments, still reckoning our Degrees from the North Horizon; setting the upper Circular Frame, and consequently the Axis of each Needle, on the Magnetic Meridian, throwing that Axis into different Elevations progressively at 15 Degrees Distance each, and calling in here, for the better elucidating the Subject, the Assistance of a Third Needle, ballanced at 45 Degrees on the Magnetic Meridian; which may serve as a Medium in our Arguments, or rather Considerations; for it seems too clear to need any Process of Arguments; bare Inspection may possibly produce sufficient Conviction in unprejudiced Observers.

ELEVATED

ELEVATED DEGREES.

Needles pointed to the Zenith	Mason's N. Vibrations.		45 Degrees N. Vibrations.		Dipping N. Vibrations.	
	N ^o .	Time.	N ^o .	Time.	N ^o .	Time.
	0	0//	4	2 in 21//	8½	2 in 13//
75	0½	in 9	4½	2 in 20	7	2 in 14
60	1	in 14	4½	2 in 19½	5	2 in 16
45	2	2 in 24	5	2 in 19	4	2 in 16
30	2½	2 in 23	5	2 in 19	1	in 8
15	3	2 in 22½	5½	2 in 20	1	in 7
N. Hor.	4	2 in 22	5	2 in 24	7	2 in 19
15	3	2 in 22½	5	2 in 20	5	2 in 16
30	2½	2 in 23	4	2 in 19	6	2 in 15
45	2	2 in 24	4	2 in 19	6	2 in 15
60	1	in 14	3	2 in 19½	7	2 in 14
75	0½	in 9	4½	2 in 20	7½	2 in 14½
Nadir	0	0	4	2 in 21	8½	2 in 13

Here we see Mr. *Mason's* Needle still preserve its Regularity, and increase in Force as it comes towards the Horizon, at which Point the increased Force of the other Needles also, shews the Action of Magnetism. The other Needles are not only irregular, but increase in Force as they recede from the Point, where they ought to be strongest: And as we know One of them to be on a wrong Principle, we may justly conclude the other to be so too.

I

Were

Were the Real Force of Magnetism sufficient to raise Weights, this might be determined to a still greater Nicety, but it is too weak to act upon Gravity.

I made one Attempt of that Nature, and could just compare the Force of the Dipping Needle in some few Planes; which alone might convince us of its having Gravity concerned in its Motion.

In its own Plane of 75, it was raised to the Horizon by 3 Grains: in the Plane of 60 by $2\frac{2}{3}$ Grains; in the Plane of 90 by $3\frac{1}{3}$; and in a Plane 105 Degrees distant from the Northern Horizon by $2\frac{2}{3}$ Grains: So that the same Force raised it at 15 and at 30 Degrees Distance from its own Plane, and there required greater Force to raise it at 15 Degrees on one Side, than in its own Plane, where it ought confessedly to have been the most powerful. Let the Advocates for the Dipping Needle reconcile this to Truth!

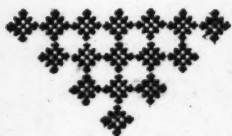
After all these Proofs, which I need not recapitulate at present, but which I am
ever

ever ready to shew to any Person of Real Science, who expresses a Desire of seeing them, - Who can any longer doubt of Gravity being joined with Magnetism in the Motion of the Dipping Needle? or who can refuse his Assent to the Horizontal Needle (ballanced across the Meridian after touching) being influenced by pure Magnetism only? Who can deny that the Boundaries of Magnetic Attraction are now settled, and that it acts towards the Horizon? And as no Power of Nature can be perfectly understood, till the Bounds of it are ascertained, those Boundaries being now known, it so lies open to the Researches of the Studious, that Solid Truth and Useful Improvements may now result from Magnetic Enquiries.

These Experiments, though last in Point of Time, are put before the Description of the Machine, in order to detect that False System of Magnetism, which betrayed the Author of the Machine into the Expence and Trouble of its Construction.

While he thought with the Crowd of Magnetists, he was sure of his Point, as

having, according to their Tenets, near 180 Degrees Space of Horizontal Attraction, (besides 75 Degrees of the Tendency under the Horizon) to overcome 105; which smallest Difference of only 75 Degrees might be deemed abundantly sufficient to overcome both the Friction, and that first Impediment of its Tendency under the Horizon, which in the Machine was so greatly taken off by an Artificial Stoppage it met with, that did not interfere with its Motion; But this and many other curious Points will appear in a clearer Light by describing the Machine.



C H A P.

C H A P. V.

*A Descriptive Account of a Machine,
which must necessarily have produced a
Perpetual Motion, if the former Systems
of Magnetism had been founded upon
Truth.*

BEFORE I enter upon this, I must
just beg Leave to make a Distinction,
the Inattention to which has seduced many
Persons into a laborious Pursuit of a Per-
petual Motion; that is, that no Machine
can be deemed an Automaton, or Perpetual
Self Mover, that is not so Universally and
in all Places; as this Machine would have
been, had the Vertical Force of pure un-
mixed Magnetism been as much stronger
than the Horizontal, as the Dipping Needle
is stronger than the Compass in all Parts of
the World.

This being premised, here follows a De-
scription of the Machine, made with the
greatest

greatest Accuracy and Perfection, by Mr. *Sisson*, upon the same Principles as that which was constructed at *Barbadoes*, but was imperfect for want of his Neatness of Work and Design.

The Author, having formed the Scheme to produce a Perpetual Motion by means of the Horizontal Attraction of two large Magnets, and concluding, that, if a Magnet, hung on its own Axis, and nicely ballanced so as to swing in a Vertical Plane, would, when so centered and ballanced, turn from North to South in a Vertical Direction, having no retarding Cause, except Friction and Resistance, then would the Horizontal Attraction (which was to bring it from South to North in a Horizontal Direction) be sufficient to give and continue that Motion; concluding also, that as the supposed Dip was so near the Center of the Earth as 15 Degrees, it would not have any material Influence on a Magnet so hung and afterwards ballanced: Upon these Conclusions, fortified with finding from Experiments tried at *Barbadoes*, that though the Magnet was impeded by a small Inclination towards

towards the North in its Vertical Oscillation from North to South, yet the Power with which it moved when Horizontal, was at *Barbadoes* so much greater than that Vertical Impediment; the Author contrived his Machine, and had the Pleasure of seeing that Horizontal Force not only give, but for some Time, with even his clumsy and ill-constructed Machine, continue that Motion at *Barbadoes*; though here, as the Powers are equal, all Motion is forbidden.

This Machine, as now improved *, has for its Basis a flat Board (A) with three adjusting Screws to keep it Horizontal: A Perpendicular (B) to the Plane of that Board, having two Arcs (C) of a Circle, and a Projecting Piece (D) at Top to confine the Top Center (E) of the Machine, the Bottom Center resting upon a Pivot on the flat Board: four Uprights (F) connected by the Top and Bottom Pieces, (G) crossing each other at right Angles: The Corner Pieces (H) at Top and Bottom to secure and strengthen it: The Axles (I,

* See Plate I.

K) of

K) of the two Magnets (L, M) at right Angles to each other, stopped by four small brass Pins (N) and carrying a Wheel (O) on each End.

The whole Machine continues a Horizontal Motion, the Magnets only having a complicated Motion arising from the Wheels, which, when they have delivered the Magnets at the North Point, catch in the Arcs of the Circles, and invert the Magnets one above, the other below, the Horizon from North to South; where the Wheels being loosed from the Arcs, leave the Magnets again to continue their Horizontal Direction: and as they cross each other at Right Angles, one is in the utmost Force of Horizontal Attraction, while the other is going from North to South Vertically; consequently if the Horizontal Force here was as much superior to the Vertical, as it is in *Barbadoes*, no Power could have hindered the Machine from going, at least as long here, as it did there: nay, it must have gone here with much greater Freedom and Facility, as the Machine made here was far more accurate, and had infinitely less Friction

Friction than the former: However the Author had Recourse to Experiments both in the Machine, and upon detached Horizontal and Vertical Magnets.

In the Machine he found that though the Horizontal Force would not turn the Vertical Magnet to the South, yet it would turn a Piece of Brass of far greater Weight than the Magnet; consequently the Stoppage of Motion did not arise from the Equality of Powers as to Gravity, but from the Increase of the Vertical Tendency; which encreasing in a far greater Proportion than the Horizontal Attraction, defeated that Power, which at *Barbadoes* was superior to it; so that from the Equator to the Poles, the Vertical Increase of Power is in a far greater Proportion than the Horizontal; and what was very observable in the Machine, was the Place of its Stopping; which was, when one of the Magnets was about 45 Degrees below the Horizon, and the other nearly the same Distance from the Magnetic North; Now, unless we suppose a Power at the Horizon, drawing that Needle upwards, which the Attraction of

K the

the other to the North endeavoured to depress, it is very difficult, not to say impossible, to account for the Position of the Machine; as by the *Halleian* System they ought to help, not hinder each other's Motion, and the descending Needle go at least as far as 75 Degrees.

He then ballanced a Magnet to swing in a Vertical Plane and rest at any Point, when crossing the Magnetic Meridian: and another Magnet of the same Size and Power was made to move horizontally on a Pivot; and he found by applying a small Piece of Steel to the Edge of a Circle that surrounded the Planes they swung in, that exactly the same Force was requisite to stop One when Vertical, and the Other when due Magnetic East and West; and that the same Force effected the same, when each was 45 Degrees from their Place of Rest: that is, when the Vertical Magnet was along the Magnetic Meridian, that Piece of Steel at the Distance of half an Inch retained it there at the Zenith; and when the Horizontal Magnet was due Magnetic East and West, the same Piece of Steel at the Distance

tance of half an Inch retained it there: At the Distance of three Quarters of an Inch that same Piece of Steel retained them both at the middle Point, that is, at 45 Degrees; so that in *England* a Vertical Magnet is attracted to the Horizon with exactly the same Force as the Horizontal Needle to the Magnetic North; therefore in the Machine as the Powers of Horizontal Attraction and Vertical Impediment are the same, no Motion can arise from them.

This, as before observed, could never have been the Case, had Magnets naturally tended to 75 Degrees below the Horizon; for upon those Principles the Author of the Machine may defy any Person to assign a Reason for its not going; and from this ill Success, and the Experiments tried in Consequence of it, it may be asserted with the greatest Confidence, that Dr. *Halley's* Hypothesis is mere Fancy, and has no Foundation in Nature; but that the Magnetic Attraction directs the Magnet Northwardly towards the Horizon only.

This naturally suggested a Thought, that possibly the *Cartesian* System (of the Magnetic Effluvia continually issuing out of the South, moving horizontally round the Earth with a Magnetic Atmosphere, and re-entering at the North Pole) might be more agreeable to Truth; and this seemed to be confirmed by their being said to preserve that Horizontal Course from South to North, and by an Experiment of a Knife, which, hanging by a String over an easy moving Pulley, with a Weight answering it at the other End so as to ballance it, might be raised up and down by a Magnet, not touching, but at some Distance from it; which at first Sight seemed to confirm *Des Cartes'* Opinion of a Magnetic Atmosphere encircling the Magnet, and therefore there was a seeming Probability of an Atmosphere of the same Nature encircling the Earth; but this was contradicted by a more certain Experiment: for as it must be granted, that if such an Atmosphere was continually moving from South to North, it must consequently be a Fluid, and affect Magnets or Steel in Proportion to their Surface, not their Contents; so to determine, whether there

there was such a Magnetic circumambient Fluid, the only Experiment necessary was —to try whether the Magnet swinging in a Vertical Plane Flatways, was attracted with greater Force than when it was Edgeways. This Experiment was carefully tried, and the Magnet was found to be attracted with exactly the same Power Edgeways as Flatways: Consequently, whatever the Occult Cause of the Magnetic Power may be, it is certain, that neither *Des Cartes* nor Dr. *Halley* have arrived at, or indeed approached to, the Knowledge of it; and that Dr. *Halley* in particular, seems, if possible, to have wandered farther from Reason in his Account, than *Des Cartes* has in his: If either of these Systems had been true, a Machine could easily have been so constructed as to produce a Perpetual Motion, that is, as far Perpetual, as perishing Matter will allow Motion to be.

Throughout the whole Course of this Treatise, I have endeavoured to write as intelligibly as I could; to avoid that mysterious Appearance, that abstruse Air, which most Authors throw upon Works of this
Nature,

Nature, and which has sometimes been used rather as a Cloak of their own Ignorance, than a Conveyance of real Instruction to others. I have thrown out Subjects (that were likely to terminate in abstracted Refinements) as Hints for others to proceed upon; and would recommend to the Consideration of those Naturalists, who would impartially weigh, and conclusively argue upon such Topicks, this Question for their Meditation and Pursuit—Whether this Discovery of the Horizontal Tendency of the Magnetic Power does not seem to open a large and new Field for their Enquiries, by its acting thus exactly at right Angles to the Action of the Elements? Earth and Water tend to the Nadir, Fire and Air to the Zenith, Magnetism to the Horizon. We here see some of the most active Principles in Nature, crossing each other at right Angles, and yet unimpeded by each other in their Progress. What Discoveries, what Truths may result from this, Time only can discover. These are Facts, the two first of them universally allowed, the latter no less certain; Facts, which any Person may rely, and proceed, upon with the greatest Security;

city ; for I declare, that I never yet heard any Objection, which when fully considered, did not furnish an additional Argument in Defence of Mr. *Mason's* Discovery.



C O N C L U S I O N.

From a strict Review of all the foregoing Premises, this Conclusion must necessarily Follow,——

Magnetism is no Fluid, nor does it act upon Surfaces, but Substantial Quality:—— Nor yet is its Direction below, but to, the Horizon ; nor (consequently) can there be any Internal Central Loadstone :——

So that the CAUSE of Magnetism remains still unknown, notwithstanding the confident Assertions of Philosophy ; and, at least till further Discoveries (which must result, not from Fancy but from Facts, not from artfully devised Systems, but from
real

real Experiments) can only be resolved into those General Laws of Nature, which the Almighty Creator has stamped upon his Creation, though He as yet with-holds them from our weak Sight, to baffle human Pride, and humble the Arrogance of Philosophy.

CONCLUSION

From a brief Review of all the foregoing Premises, this Conclusion must necessarily follow—

F I N I S.



So that the
 still unknown,
 dont Affections of Philosophy; and, at
 least till further Discoveries (which must
 come from Fancy but from Facts, not
 from artificially devised Systems, but from

